

Evaluation of the Tracy Fish Collection Facility Holding Tank Screen Entrainment Efficiency for Juvenile Delta Smelt

Investigators

Brandon J. Wu

Fisheries Biologist
Tracy Fish Collection Facility
Bureau of Reclamation
Byron, CA 94514
bwu@usbr.gov

Brent Bridges

Fisheries Biologist
Tracy Fish Collection Facility
Bureau of Reclamation
Byron, CA 94514
bbridges@usbr.gov

Summary

The Department of the Interior, Bureau of Reclamation (Reclamation), Tracy Fish Collection Facility (TFCF) is located at the head of the Delta-Mendota Canal (DMC) 4 km northeast of the C.W. “Bill” Jones Pumping Plant (JPP; formerly Tracy Pumping Plant) and 14.5 km northwest of Tracy, California (San Joaquin County). Reclamation’s JPP exports up to 130.26 cubic meters per second (cms) of water south for agricultural, municipal, and industrial use out of the Sacramento-San Joaquin Delta (SSJD; Arthur *et al.* 1996). The TFCF was built in 1956 by Reclamation to remove Chinook salmon (*Oncorhynchus tshawytscha*) and striped bass (*Morone saxatilis*) ≤ 20 -mm FL from the DMC. Once fish are removed from the DMC, they are held in 6.1-m-diameter concrete holding tanks for 8–12 h or until transportation back to the Delta is deemed necessary according to the Bates truck loading tables. The number of fish in the holding tanks and haul-out trucks are estimated using the fish count procedure in which a sub-sample of the water flowing into the tanks is taken every 2 h. It is possible that juvenile delta smelt between 20 and 30 mm are lost through the holding tank screen during the 8- to 12-h holding period, which may result in pump mortality as well as inaccurate estimation of the both the number of fish salvaged and the fish loading densities in the fish haul truck.

In 2004 and 2005 the fish count procedure was tested for its efficiency in retaining juvenile delta smelt (*Hypomesus transpacificus*). These data were released in 2007 and indicate a large percentage (60%) of delta smelt 20–30 mm FL are passing through the screen commonly used to condense fish during fish counting procedures (Sutphin *et al.* 2007) and are therefore not counted. Consequently, the number of larval and juvenile fish salvaged between sub-samples may be greater than estimated, which can result in the fish-haul truck transporting overly high densities of fish, affecting water quality and possibly survival. From the 2007 study, it was determined that a fish count screen hole size of ≤ 2.5 mm in diameter is needed for a 20-mm FL delta smelt to not be lost through the screen holes (Sutphin *et al.* 2007). The current holding tank screen

maximum diameter is 4.3 mm (Sutphin *et al.* 2007); therefore larval and juvenile fish loss from the holding tank screens is expected and may be as large as determined at the fish count station screen. The movement of entrained fish through the holding tank screens likely results in loss, due to the fact that fish are pumped out of the TFCF and down the DMC, and does not allow for accurate estimation of fish loading densities in the fish haul truck by extrapolation of fish count data. Determining which size classes of delta smelt are effectively retained in the holding tank will help us to verify the effectiveness of the current holding tank screen at retaining ≥ 20 -mm delta smelt as well as gain insight on the accuracy of TFCF juvenile smelt salvage data and the accuracy of the fish loading densities in the fish haul truck.

In FY 2010 a 500- μ m net was used to quantify holding tank screen fish entrainment (*i.e.*, loss through holding tank screen holes) of five size classes of delta smelt, between 10.0 and 34.9 mm SL, during 0-, 1-, 5-, 15-, and 30-min swirl periods. Results of these experiments suggest that, on average, 95.7% of the 10.0–14.9 mm SL delta smelt, 95.7% of the 15.0–19.9 mm SL delta smelt, 87.4% of the 20.0–24.9 mm SL delta smelt, 98.1% of the 25.0–29.9 mm SL delta smelt, and 100.0% of the 30.0–34.9 mm SL delta smelt were successfully recovered in the net during the 0-min swirl replicates. On average, 95.4% of all injected fish were recovered in the net during 0-min swirl replicates. On average, 96.3% of the 10.0–14.9 mm SL delta smelt, 92.4% of the 15.0–19.9 mm SL delta smelt, 93.3% of the 20.0–24.9 mm SL delta smelt, and 100.0% of the 24.0–29.9 and 30.0–34.9 mm delta smelt were recovered during the 1-min swirl replicates. On average, 96.4% of all injected fish were recovered in the net during the 1-min swirl replicates. On average, 79.7% of the 10.0–14.9 mm SL size class, 86.9% of the 15.0–19.9 mm SL size class, 83.5% of the 20.0–24.9 mm size class, 98.2% of the 25.0–29.9 mm size class, and 100.0% of the 30.0–34.9 mm size class were recovered in the 5-min swirl replicates, whereas 39.2%, 68.4%, and 85.4% recovery was observed for the 10.0–14.9, 15.0–19.9, and 20.0–24.9 mm SL size classes, respectively, during the 15-min swirl replicates. On average, 89.6% and 64.3% of all injected fish were recovered during the 5-min and 15-min swirl replicates, respectively. During the 30-min swirl replicate 69.3% of the 10.0–14.9 mm SL size class, 84.3% of the 15.0–19.9 mm SL size class, 80.2% of the 20.0–24.9 mm SL size class, 99.0% of the 25.0–29.9 mm size class, and 100.0% of the 30.0–34.9 mm SL size class were recovered. On average, 86.6% of all injected delta smelt were recovered during 30-min swirl replicates. It was determined that a 26.0-mm SL delta smelt is retained by the current holding tank screen 100% of the time, regardless of the swirl period.

All equipment for this study was purchased in 2007 (500- μ m net, net frame) although work was not possible due to construction activity at the TFCF. Modifications (collar was added in order to fit net to frame) to the net were made in March 2008. Two new 500- μ m nets were ordered and received before the FY 2009 study period and were used for 2010 research activity. Collection of data was completed for this project in July 2010.

Problem Statement

The loss of delta smelt between 20 and 30 mm through the holding tank screen results in pump mortality at the JPP as well as inaccurate estimation of both the number of fish salvaged and the fish loading densities in the fish haul truck. The primary

objective of this study is to determine the holding tank screen entrainment efficiency for five size classes (10–14.9, 15–19.9, 20–24.9, 25–29.9 and 30–34.9 mm SL) of larval and juvenile delta smelt during 0, 1, 5, 15 and 30-min swirl periods. Determining which size classes of delta smelt are effectively retained in the holding tank will help us to verify the effectiveness of the current holding tank screen at retaining ≥ 20 -mm delta smelt as well as gain insight on the accuracy of TFCF juvenile smelt salvage data along with the accuracy of the fish loading densities in the fish haul truck.

Goals and Hypotheses

Goals:

1. Determine the holding tank screen entrainment efficiency for five size classes (10–14.9, 15–19.9, 20–24.9, 25–29.9 and 30–34.9 mm TL) of larval and juvenile delta smelt during 0-, 1-, 5-, 15- and 30-min swirl periods.
2. Develop a probability-capture curve for larval and juvenile delta smelt based on standard length (10–14.9, 15–19.9, 20–24.9, 25–29.9 and 30–34.9 mm) and the amount of time swirled in the holding tanks (0, 1, 5, 15 and 30 min).

Hypotheses:

1. The holding tank screen entrainment efficiency will increase with increasing size of larval and juvenile delta smelt for 0-, 1-, 5-, 15- and 30-min swirl periods.
2. The holding tank screen entrainment efficiency for all size classes will be reduced with increased swirl time.

Materials and Methods

Holding Tank Screen Efficiency Experiment

In order to develop a probability-capture curve for fish size and swirl time, determine the holding tank screen entrainment efficiency during the routine 30-min fish counts performed at the TFCF during delta smelt season, and verify if the current holding tank screen size is sufficient in retaining ≥ 20 mm delta smelt during 30-min fish counts, 0-, 1-, 5-, 15- and 30-min samples were made in TFCF holding tanks during a period of time when there was an adequate water temperature (14.6–17.5°C) and no wild delta smelt present, for take purposes. Delta smelt were picked up from the FCCL, transported to the TFCF in 18.9-L black buckets with lids, and held in ambient Delta water prior to insertion. The net and frame were placed in the drainage pit using the same hoist intended for the fish count and haul-out buckets and the holding tank was filled using the “collect” valve. A known number of unmeasured cultured delta smelt were inserted into the holding tank using a water-to-water method in which the 18.9-L black buckets was lowered with a rope and poured. Holding tank valves were put into operation to initiate collection and waterflow through the holding tank screen. During the specified collection period, flow was regulated using holding tank pumps (one or two) to mimic typical flow rates when wild delta smelt are salvaged. Flow rates (cms), tank water depths (m), and temperature (°C) were recorded. After the collection period, the holding tank was drained to an approximate depth 0.6 m. The net and frame was lifted out of the drainage pit and

sample 1 (fish that were not effectively withheld in the holding tank) was collected by rinsing the net into 18.9-L buckets. The net and frame was then reinserted into the holding tank and the “collect” valve was used to fill the holding tank until water levels inside and outside of the holding tank screen were equal. This process eliminated the problem of a sudden force of water lifting our net frame and the possible loss of fish. Once equilibrium was achieved, the holding tank screen was lifted up and sample 2 (fish that were effectively withheld in the holding tank) was collected in our net. The holding tank was then rinsed using solely a high pressure hose and our net was removed and rinsed into 18.9-L buckets. The samples were then separately consolidated into one fine-meshed (0.39-mm) dipnet by pouring the contents of each 18.9-L bucket into the dipnet. The samples were then bathed for 5 min in Rose Bengal for staining. After this, the samples were thoroughly rinsed and placed into a pyrex dish on a light table. All delta smelt were picked out of the samples. SL, FL, total length, and maximum depth (from the insertion of the first dorsal ray to the insertion of the first anal ray) were measured for all delta smelt collected using a Leica™ MZ7₅ stereomicroscope (Leica Microsystems, Bannockburn, Illinois) equipped with a micrometer. Bycatch of fish ≥ 20 mm were identified to species and measured (FL). It was necessary to release approximately 500 fish at each size/time combination in order to estimate efficiency within 5% with a power of 0.8.

Data Analyses

Three replicates for each size class and swirl time were completed. Analysis of covariance will be used to determine if fish size and length of swirl significantly change the probability of capture. A probability-capture curve, with 95% confidence intervals, will then be developed using the Logit link function for fish size and swirl time. This probability-capture curve will allow us to determine the holding tank screen entrainment efficiency, for the six size classes of juvenile delta smelt, during 0-, 1-, 5-, 15- and 30-min swirl periods. Linear regression will be used to determine the relationship between waterflow rates in the holding tank and fish loss. Data analysis will be completed by August 2011.

Coordination and Collaboration

All experiments will be coordinated with the TFCF Fish Diversion Operators (Joel Imai) along with the TFCF Biology staff (Brent Bridges). During data collection it will be necessary to utilize a TFCF holding tank and the bucket hoist. Participation and inclusion of research-related updates will be provided at regularly scheduled Tracy Technical Advisory Team (TTAT) and/or Central Valley Fish Facilities Review Team meetings.

Endangered Species Concerns

We will be using larval and juvenile stages of domestically reared delta smelt and have timed the tests so that they do not coincide with periods when wild ESA listed delta smelt are present. However, incidental “take” of ESA listed Chinook salmon and/or steelhead trout (*O. mykiss*) is likely to occur during the tests. If collected, ESA listed Chinook salmon and steelhead trout will be measured and released alive back into the

normal salvage operations. All larval and/or juvenile delta smelt that are encountered during testing will not be released alive back into the Delta.

Dissemination of Results (Deliverables and Outcomes)

A Tracy Series Report volume will be prepared and published upon completion of the study. Updates and presentations of progress will be provided internally and upon request by TTAT and other interagency technical forums. A draft report is tentatively scheduled to be completed by September 2011 and a final draft report will be finished by December 2012.

Literature Cited

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